



Peer-Reviewed Case Report

Ligation of the Outflow Graft of the Left Ventricular Assist Device for Management of Hemolysis Due to Pump Thrombosis

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Citation: Touchan, J et al. (2016). "Ligation of the outflow graft of the left ventricular assist device for management of hemolysis due to pump thrombosis"

The VAD Journal, 2. doi: <http://dx.doi.org/10.13023/VAD.2016.20>

Editor-in-Chief: Maya Guglin, University of Kentucky

Received: August 16, 2016

Accepted: September 04, 2016

Published: September 7, 2016

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Funding: Not applicable

Competing interests: Not applicable

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Abstract

Pump thrombosis is a serious complication of continuous-flow left ventricular assist devices (LVAD). Treatment options include medical thrombolysis, surgical pump exchange or urgent heart transplantation. We are reporting a case of pump thrombosis with active hemolysis and acute renal failure managed surgically by isolating the LVAD while awaiting renal recovery and donor heart availability.

Keywords: Circulatory support devices, VAD complications, Heart failure, ventricular assist device

Case Presentation

A 43 year-old male with end-stage non-ischemic cardiomyopathy underwent Heartmate II LVAD implantation one year prior as bridge to decision (active cigarette smoking). Subsequently he required pump exchange for pump thrombosis at 6 months post-implantation. Two months following pump exchange, he again developed pump thrombosis and was transferred to our institution for consideration of urgent heart transplant listing. On arrival he was hemodynamically stable. Clinical exam demonstrated clear breath sounds bilaterally, harsh LVAD humming, palpable pulses in all extremities, jugular venous distension 4 cm above the clavicles and minimal peripheral edema. Urine revealed gross hemolysis with dark Coca-cola discoloration. Initial lab work showed an elevated lactate dehydrogenase (LDH) (714 U/L), mildly elevated NT



pro B-type natriuretic peptide (NT-proBNP) (1046pg/ml) and serum creatinine of 1.9 mg/dL. Blood count demonstrated hemoglobin of 8 g/dL and hematocrit 25.4%. International normalized ratio (INR) on admission was 1.1 despite warfarin compliance. ABO blood group was type A, and panel reactive antibody screen was 0% for class I and class II.

LVAD interrogation revealed high power spikes and low pulsatility index. Transthoracic echocardiography showed a severely dilated left ventricle (left ventricular end diastolic diameter 6.8 cm) and left ventricular ejection fraction of 20%. A moderate-sized apical thrombus was identified at the LVAD inflow cannula (Figure 1). Right heart catheterization demonstrated normal cardiac filling pressures (central venous pressure 3 mmHg, pulmonary artery pressure 21/8 mmHg, pulmonary capillary wedge pressure 6 mmHg). Fick cardiac output was measured as 6.11 L/min with cardiac index of 2.8 L/min/m² and measured mixed venous oxygen saturation of 49%. Thermodilution cardiac output was measured at 5.57 L/min.



Figure 1a. Apical 4 chamber view of transthoracic echocardiogram showing the apical thrombus.

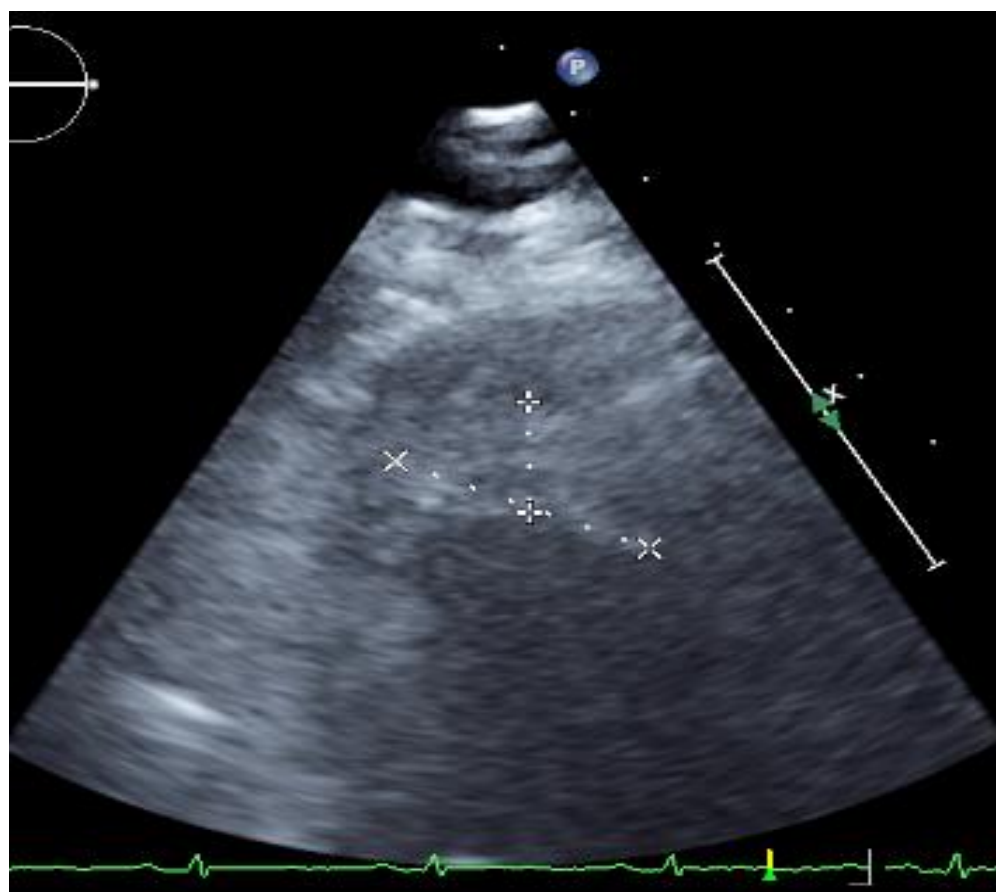


Figure 1b. Zoomed image with the dimension of the thrombus measuring 2.6x1.2 cm.

Intravenous anticoagulation was initiated with heparin infusion for pump thrombosis and hypercoagulability assessment was performed. Despite therapeutic heparin anticoagulation, LDH levels continued to rise (3700 U/L) and the patient developed worsening acute renal injury (serum creatinine 4.37 mg/dL). Expedited heart transplant evaluation was undertaken, however due to worsening renal injury he required urgent intervention to eliminate ongoing hemolysis.

Decision was made to isolate the LVAD from circulation and maintain his hemodynamics with inotropic support. The LVAD outflow graft was isolated and ligated via subxyphoid incision and the driveline was disconnected from the device controller. Hemodynamically he remained stable on low dose milrinone infusion, and heparin anticoagulation was continued for the apical thrombus. Following outflow graft ligation, urinary discoloration quickly cleared and renal clearance improved in the following 2 weeks (Figure 2) thereby permitting active listing for transplant. He was stable without inotropes and subsequently underwent heart transplantation and LVAD explant 1 week later.

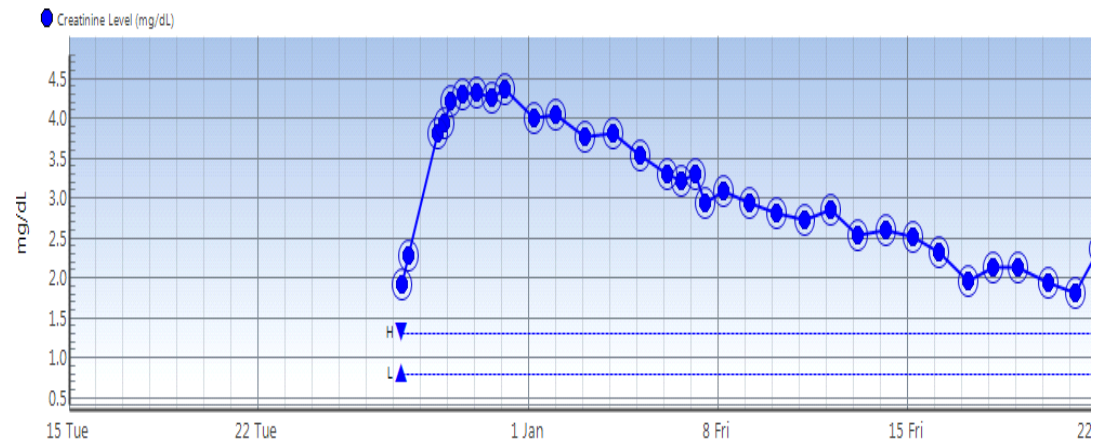


Figure 2. Creatinine trend from admission day 12/27/2015 till transplant date 1/21/2016. Note that the creatinine level plateaued 12/28 and 12/29, the patient had LVAD ligation performed 12/29/15, and gradual kidney function recovery was noticed since.

Discussion

LVAD pump thrombosis is a major complication with increased incidence in recent years with continuous flow devices. Emphasis has been placed on surgical technique and cannula malalignment as major contributing factors to the recent surge in Heartmate II LVAD device thrombosis [1]. Recently, Starling et al [2] summarized the experience of 3 US centers with 72 confirmed HeartMate II pump thromboses. A significant 6-month actuarial mortality (48.2%) was noted in those patients managed medically without heart transplant or pump exchange, underscoring the importance of surgical intervention. Treatment of pump thrombosis can include VAD exchange or explant, heart transplantation, or medical thrombolysis depending on the clinical presentation and patient candidacy for transplantation [3].

In the case presented, LVAD ligation was felt to be the most feasible option to eliminate ongoing hemolysis and permit renal recovery for transplant listing, considering the stable hemodynamics and appearance of adequate cardiac function on transthoracic echocardiogram. The alternative option of repeat pump exchange was complicated by the extent of left ventricular thrombus and concern of cannula malalignment that precipitated the repeated thrombosis. The feasibility of our approach as a short-term intervention hinged upon our patient being non-sensitized with preformed antibodies thereby facilitating donor heart matching.

LVAD outflow graft ligation has not been previously described for the management of pump related hemolysis. Baldwin et al [4] described various HeartMate II explant options in the setting of left ventricular recovery in which the technique of outflow graft ligation has been successfully demonstrated. Alternatively, driveline transection also was reported as a surgical option for selected cases in which LVAD thrombosis occurred during the LVAD weaning process. Consideration of



this option in our case may also have been well tolerated and resulted in similar success with elimination of hemolysis as LVAD isolation is similarly accomplished.

Conclusion

In summary, we describe Heartmate II outflow graft ligation (LVAD isolation) and reversion to medical management of heart failure as a feasible short-term option to eliminate LVAD associated hemolysis and permit renal recovery.

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